



Application of Decision Support in Performance Assessment of Delivery Services in the E-Commerce Industry

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ABSTRACT

The e-commerce industry is experiencing rapid growth along with increasing consumer demand for fast, precise and reliable delivery services. Assessing the performance of goods delivery services is very important to ensure customer satisfaction and operational efficiency. This research aims to develop a decision support model to assess the performance of goods delivery services in the e-commerce industry using the Analytical Hierarchy Process (AHP) method. The AHP method was chosen because of its ability to resolve conflicting criteria through a pairwise comparison matrix and decompose problems, criteria and alternatives into a decision hierarchy. In this research there are 5 assessment criteria, namely Price (C1), Goods Packaging (C2), Goods Delivery C3), Service (C4), and Number of Branches (C5). Source of data from respondents obtained using questionnaire techniques. The research results show the final ranking of 4 alternative delivery services. From these results it can be explained that the highest criteria weight value in criterion C1 can influence the ranking results, because the AHP method is a criteria weighting method that takes into account criteria through a pairwise comparison matrix.

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1. Introduction

Technological advances have brought significant changes in the business paradigm, especially in goods delivery services. Choosing a delivery message has become crucial in efforts to meet the increasing needs of customers. In order to improve service quality and operational efficiency, goods delivery service companies must ensure the use of optimal selection of messages between goods delivery. People's needs are increasing and many online businesses are emerging. Someone can shop or carry out daily activities online, in this way the activities carried out by someone can be done in an easy and practical way.

Service businesses are currently very much needed and have an influence on consumers' daily activities. This results in consumers having many choices to choose from a courier service for delivering goods that can be trusted, provides the best service, and affordable prices, so that satisfying consumer activities regarding the distribution of goods over long distances can be channeled well (Kabadayi et al., 2020; Tao et al., 2022). All consumers need fast and safe delivery of goods to ensure

that the goods sent arrive at the right time. Along with developments occurring in all fields, the level of consumers for goods delivery services is increasing. Consumers' decisions in choosing delivery services are not easy, in determining which delivery of goods is on time and good (Yunanto et al., 2024). Choosing a delivery order for goods is very important and must match the desired criteria, for this reason the public is required to be wiser in choosing a delivery order to avoid fraud from a number of unofficial delivery services. Sometimes the process of sending goods via land, sea and air transportation is found in many areas in Indonesia where goods delivery services are in great demand.

Delivery services are a form of service that offers convenience in the process of sending goods from one city to another safely and can be accounted for by the goods delivery service provider. So it becomes an important factor in maintaining customer loyalty in using delivery services so that the goods purchased can arrive well (Violin et al., 2022). It is necessary to determine the performance assessment of goods delivery services used in E-Commerce transactions in evaluating the performance of delivery services for service users.

Research regarding the performance assessment of goods delivery services by (Gupta et al., 2022; Wahyuni et al., 2022) which shows that delivery speed and cost are the dominant factors in selecting a delivery service (Santoso et al., 2024). Other research by (Nguyen et al., 2021; Pamucar et al., 2021) uses the Multi-Criteria Decision Making (MCDM) method to evaluate delivery service performance. They found that besides cost and speed, service quality and area coverage also played an important role in decision making. In implementing a decision support system, it is necessary to have an appropriate method so that the assessment can be carried out objectively and facilitate the explanation of the problems, criteria and selected alternatives (Harjanti et al., 2023; Rony et al., 2023; Sudipa et al., 2024). In this research, the Analytical Hierarchy Process (AHP) method is used, this method is suitable for solving a complex problem consisting of multiple criteria so that it can consider the existence of conflicts between criteria (Munier & Hontoria, 2021), construct a decision hierarchy and determine the consistency of the resulting weight values. With things that must be considered in terms of aspects and criteria, the complexity in solving problems is caused by a series of uncertainties in the problem (Rustiawan et al., 2023) can be overcome by the Saaty value scale which is used to support objective assessment.

The urgency of the problem faced by goods delivery services is that the level of service and accuracy of delivery of goods is not as expected by customers, resulting in many complaints from service users due to the goods they order arriving outside the time specified by the goods delivery service. Service quality is an important factor that companies must pay attention to. Defining service quality as the expected level of excellence and control over this level of excellence to fulfill customer desires in E-Commerce such as Shoope, Lazada, Tokopedia and Bukalapak.

Based on the explanation above, the aim of this research is to determine the best delivery service to use in the e-commerce industry based on performance assessment using the AHP method. By analyzing the main criteria that influence customer decisions, this research aims to provide appropriate and data-based recommendations. The delivery services that will be analyzed include the five most popular delivery services in the marketplace, namely JNE, J&T Express, SiCepat Ekspres, and Ninja Xpress.

2. Literature Review

In the e-commerce industry, decision support systems are essential for evaluating delivery service performance. The Analytical Hierarchy Process (AHP) is a key methodology that enables the structured assessment of multiple criteria and alternatives (Chandra et al., 2019; Sudipa et al., 2022). These decision support systems enhance customer experiences and overall value creation by integrating customer reviews, service quality, and logistics coordination (Gupta et al., 2022; Kayvanfar et al., 2024; Yazdani et al., 2020). By utilizing these tools, businesses can optimize operations, improve service quality, and boost customer satisfaction (Wisnujati et al., 2023). Factors influencing e-commerce adoption among enterprises, particularly small and medium-sized businesses, include top management support, applicability, and organizational security (Pamucar et al., 2021). Understanding these factors is crucial for successful e-commerce implementation. In the domain of delivery services, especially last-mile distribution, effective coordination and information

sharing among partners are vital for enhancing express delivery service performance and overall supply chain efficiency in e-commerce (Zhong et al., 2020). Sustainable practices in e-commerce, covering environmental, social, and economic dimensions, are key for long-term success and customer trust (Harahap et al., 2023). By focusing on sustainability, businesses can optimize resource utilization, manage costs, and improve customer loyalty through enhanced service quality and responsiveness. In summary, the application of decision support systems like the Analytical Hierarchy Process in evaluating delivery service performance in e-commerce is crucial for improving operational efficiency, customer satisfaction, and overall business success. By leveraging insights from research on e-service quality, logistics coordination, sustainability practices, and factors influencing e-commerce adoption, businesses can make informed decisions to drive growth and competitiveness in the digital marketplace.

3. Research Methods

This research will use AHP (Analytical Hierarchy Process) method, which is one of the techniques in decision making. In making decisions, we have criteria as a basis for judgment, and we will also be faced with more than one choice. If there are two alternatives, it may still be easy for us to choose, but if there are many alternatives, it is quite difficult for us to decide. AHP is a technique developed to help overcome this difficulty (Munier & Hontoria, 2021). In AHP method, all alternative choices are fought one-on-one, like in a soccer match with a half-competition system. The score of each pair is then tabulated to calculate the total score for each alternative.

The Analytical Hierarchy Process (AHP) method offers a number of advantages that make it a very effective tool in multi-criteria decision making. First, AHP allows decision makers to decompose complex problems into simpler and structured elements in the form of a hierarchy, starting from objectives, criteria, sub-criteria, to alternatives. This makes it easier to understand and analyze each element separately and in the context of the whole. Second, AHP uses a systematic weighting process for each criterion and sub-criteria based on their level of importance, which is then integrated into the final assessment (Leal, 2020). This process involves pairwise comparisons which help produce more accurate and objective weights. Third, AHP is able to accommodate both quantitative and qualitative data, so it is flexible for various types of problems and situations. Fourth, this method also provides a tool for measurement consistency, enabling decision makers to evaluate and improve consistency in their judgments. Fifth, AHP produces output in the form of alternative rankings based on composite scores, thereby providing clear and accountable recommendations (Khan & Ali, 2020; Santika et al., 2022). With these advantages, AHP has become a reliable method and is often used in various fields, including management, logistics, and business strategy, to support complex and critical decision making.

Stages of AHP Method

The calculation procedure/steps in using the AHP method are as follows (Leal, 2020; Munier & Hontoria, 2021):

1. Determine the criteria data.
2. Create Decision Hierarchy
3. Determining the value of criteria using pairwise comparisons based on a comparison scale of 1-9 (according to theory). This data becomes matrix data.
4. Add up the values in each column of the matrix created earlier.
5. Divide each value of the column by the total of the column concerned to obtain matrix normalization. The resulting data is normalized data.
6. Summing up the values of each row and dividing it by the number of elements to get the average value. The resulting data is priority data per criterion
7. Multiply each value in the first column by the relative priority of the first element, the value in the second column by the relative priority of the second element, and so on.

8. Sum each row
9. The result of the row sum is divided by the corresponding relative priority element.
10. Sum the quotient above with the number of elements present, the result is called λ max
11. Calculate the Consistency Index (CI) with the formula:

$$CI = (\lambda \text{ max} - n) / n \quad (1)$$

Description:

n = number of criteria or sub-criteria

$c1$ = consistent index

where n is the number of elements.

12. Calculate the Consistency Ratio (CR) with the formula:

$$CR = CI/IR \quad (2)$$

where IR is the Random Consistency Index.

13. Checking the consistency of the hierarchy. If the value is more than 10%, then the judgment data must be corrected. However, if the consistency ratio (CI/IR) is less than equal to 0.1, then the calculation results are declared correct.

AHP Hierarchy Structure

The hierarchy in the Analytical Hierarchy Process (AHP) method has the main function of structuring and organizing complex problems into simpler and more structured elements. This allows decision makers to separate main objectives, criteria, subcriteria, and alternatives, so that each part of the problem can be analyzed separately but within the context of the whole. Organizing information through a hierarchy helps identify relationships between elements and ensures that all important aspects of the decision have been considered (Munier & Hontoria, 2021). Additionally, hierarchies allow for assigning weights to each element based on their importance relative to the end goal, with a pairwise comparison process assisting in determining more accurate priorities and weights.

The benefits of using hierarchies in AHP are very significant in facilitating decision making. By decomposing the problem into a hierarchical form, decision makers can more easily understand and analyze each element involved, making the decision-making process more systematic and structured (Kharisma, 2021). Additionally, hierarchies improve consistency in judgment because they make it easier for decision makers to consistently compare elements at each level, helping to identify and correct inconsistencies (Khan & Ali, 2020; Leal, 2020). Hierarchies also offer flexibility, allowing adaptation to different types of problems and situations, both involving quantitative and qualitative data. Finally, the hierarchical structure provides transparency in the decision-making process, because each step in determining the weight and evaluation of alternatives can be traced and understood, so that the decisions taken are more easily justified.

This research uses assessment criteria obtained from 100 respondents who are active users of e-commerce services in Indonesia. So it is obtained based on five main criteria: Price (C1), Goods Packaging (C2), Goods Delivery (C3), Service (C4), and Number of Branches (C5). The form of the Decision Hierarchy of the AHP method is:

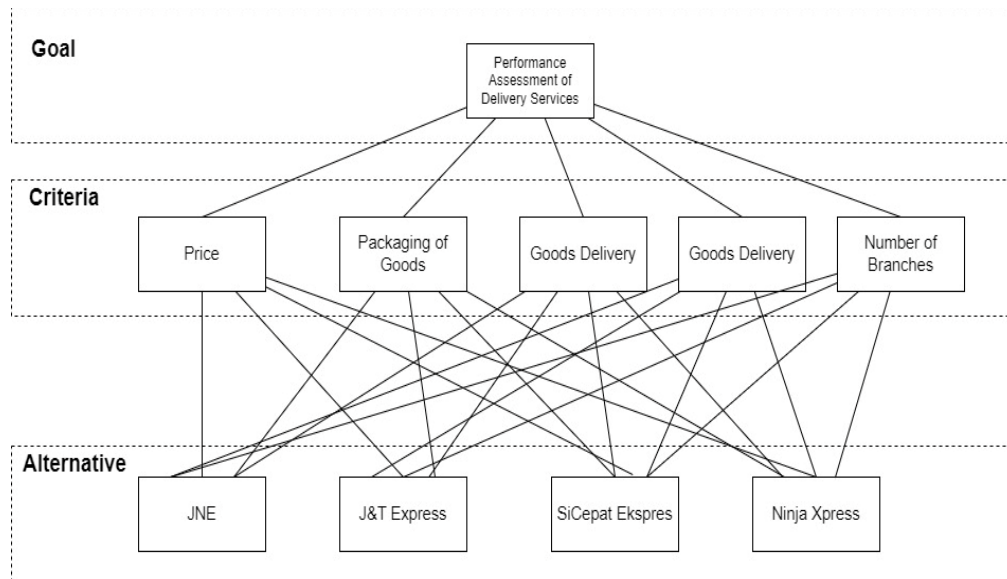


Fig 1. AHP Hierarchy for Determining Goods Delivery Service Assessment

Based on Figure 1, it can be explained that at the top there is a goal or purpose for completing the performance assessment of goods delivery services, then there are criteria (C) which consist of Price (C1), Goods Packaging (C2), Goods Delivery (C3), Service (C4), and Number of Branches (C5). Next, there is alternative (A) which consists of 5 alternatives, namely JNE (A1), J&T Express (A2), SiCepat Express (A3) and Ninja Express (A4).

4. Results and Discussions

4.1. Data Analysis

Criteria data collection is obtained using a questionnaire technique. The questionnaire is a data collection method by providing a list of questions to users who will be studied as respondents, The assessment criteria were obtained from 100 respondents who are active users of e-commerce services in Indonesia. The questionnaire was distributed through an online method using a survey platform such as Google Forms regarding the selection of delivery services. The questionnaire was designed to collect data on respondents' perceptions and experiences of delivery services based on five main criteria: Price, Goods Packaging, Goods Delivery, Service, and Number of Branches.

4.2. AHP Method Calculation

Criteria Analysis

In the criteria analysis there is an explanation regarding the assessment criteria that have been obtained from collecting questionnaire data, namely Price Criteria (C1) are the fees charged for goods delivery services. Goods Packaging (C2) relates to the quality and safety of packaging goods during delivery. Goods Delivery (C3), namely the speed and timeliness of goods delivery according to estimates. Service (C4), namely the quality of customer service, including ease of tracking and responsiveness. As well as the number of branches (C5), namely the regional coverage and the number of branches the delivery service has. The criteria used in determining the best employee can be seen in table 1.

Criteria	Criteria Name
C1	Price
C2	Packaging of Goods
C3	Goods Delivery
C4	Services

C5 Number of Branches

The table above explains the assessment criteria as a reference for evaluating shipping service selection decisions.

Alternative Analysis

In this study, the authors took 4 existing goods delivery services that were used as alternatives in the selection process. The following are the types of goods delivery that are alternatives, namely:

Table 2. Alternatives

Alternative	Description
A1	JNE
A2	J&T Express
A3	SiCepat Express
A4	Ninja Express

Stages of Calculating Criteria Weights using the AHP Method

At the stage of calculating the criteria weights using the AHP method, it begins with determining the value of the pairwise comparison matrix of the criteria. In this case, the scale value used is 1 to 9, namely using the Saaty Scale value, the decision maker who provides the assessment is the respondent, by looking for the average value of each respondent against the value of each criterion

Table 3. Pairwise Comparison Matrix of Criteria

Criteria	C1	C2	C3	C4	C5
C1	1	2	3	2	4
C2	0,5	1	2	2	2
C3	0,3333333	1	1	2	2
C4	0,5	0,5	0,5	1	2
C5	0,25	0,5	0,5	0,5	1
Total	2,5833333	5	7	7,5	11

The stage continues by determining the normalization value of the pairwise comparison matrix

Table 4. Matrix Normalization

Criteria	C1	C2	C3	C4	C5	Total	Average
C1	0,387	0,4	0,429	0,267	0,36	1,846	0,369
C2	0,194	0,2	0,286	0,267	0,18	1,128	0,226
C3	0,129	0,2	0,143	0,267	0,18	0,92	0,184
C4	0,194	0,1	0,071	0,133	0,18	0,68	0,136
C5	0,097	0,1	0,071	0,067	0,09	0,426	0,085

$\lambda_{\max} = 3,109$
 CI = 0,054
 CR = **0,09** because the value is less than 0.1 it is consistent

Based on the results of table 3, it can be explained that the average eigenvector value is a weight value resulting from the AHP method calculation, so then check the lambda max value using equation (1), calculate the CI value using equation (2) and finally calculate the consistency value ratio (CR)

using equation (3), from the results of the CR value, a value of 0.09 is obtained, which is less than the value of 0.1 so that the criteria weight value is declared consistent and can be used in the final alternative calculation.

Table 5. Weight Criteria of Service User Preferences

Criteria	Weight
Price	0,369
Packaging of Goods	0,226
Goods Delivery	0,184
Services	0,136
Number of Branches	0,085
Total	1

Alternative Rating Value Stages

The alternative value is obtained from the respondent's assessment of each alternative based on 5 assessment criteria. In determining the alternative rating value, use values 1 to 5. So the average value of the respondent's assessment of each alternative is calculated.

Table 6. Alternative Values for Each Criteria

Alternative	C1 (0,369)	C2 (0,226)	C3 (0,184)	C4 (0,136)	C5 (0,085)
A1	5	4	4,5	4	5
A2	4	5	5	4	5
A3	4	4	5	4	3
A4	4	5	5	4	3

Calculation of Final Ranking Values

Determine the final value of the alternative by multiplying the alternative value on the criteria by the weight value of the criteria. Finally, the total up the overall results. The formula below shows the final value of each possibility.

$$V_1 = (5 \times 0,369) + (4 \times 0,226) + (4,5 \times 0,184) + (4 \times 0,136) + (5 \times 0,085) = 4,546$$

$$V_2 = (4 \times 0,369) + (5 \times 0,226) + (5 \times 0,184) + (4 \times 0,136) + (5 \times 0,085) = 4,495$$

$$V_3 = (4 \times 0,369) + (4 \times 0,226) + (5 \times 0,184) + (4 \times 0,136) + (3 \times 0,085) = 4,099$$

$$V_4 = (4 \times 0,369) + (4 \times 0,226) + (5 \times 0,184) + (4 \times 0,136) + (3 \times 0,085) = 4,324$$

After computing the final value of the possibilities, order them from largest to smallest. Table 6 shows the final ranking of alternatives.

Table 6. Final Alternative Ranking Score

Alternative	Value	Ranking
A1	4,546	1
A2	4,495	2
A4	4,324	3
A3	4,099	4

The results of the final ranking show that alternative A1, namely the JNE delivery service, is the best alternative with a value of 4,546, then ranking 2 is alternative A2, namely J&T Express with a value of 4,495, the third ranking alternative is alternative A4, namely Ninja Express with a value of 4,324 and the fourth ranking is alternative A4 is SiCepat Express. From these results it can be explained that the highest criteria weight value in criterion C1 can influence the ranking results,

because the AHP method is a criteria weighting method that takes into account criteria through a pairwise comparison matrix.

5. Conclusion

The research conclusion is that the application of the AHP method in determining goods delivery services in the E-Commerce industry has been successfully carried out by showing that JNE delivery service is the best alternative with a score of 4,546, then ranking 2 is alternative A2, namely J&T Express with a score of 4,495, the third ranking alternative is alternative A4, namely Ninja Express with a score of 4,324 and fourth ranking is alternative A4, namely SiCepat Express. The AHP method is very superior in explaining the structure of problems, criteria and alternatives through a decision hierarchy, and can determine the weight of criteria by taking into account conflicting criteria through a pairwise comparison matrix. This result is an alternative decision obtained from the respondent's questionnaire assessment. There are still research weaknesses in the saaty scale assessment technique because there are many respondents who provide assessments and each respondent must understand the scale values from 1 to 9, so the suggestion for future research is to apply alternative assessment techniques. without going through the process of determining the weighting of the criteria.

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